



United States Department of the Interior

BUREAU OF RECLAMATION

Upper Colorado Regional Office
125 South State Street, Room 6107
Salt Lake City, Utah 84138-1102

IN REPLY REFER TO:

UC-720
ENV-7.00

MAR 13 2001

MEMORANDUM

To: Technical Work Group Members and Alternates

Through: Kanab Ambersnail Working Group Participants (see attachment)

From: Christine D. Karas
Chief, Environmental Resources Group

Subject: Kanab Ambersnail Working Group Response to the Expert Panel Review

On December 1-3, 1999, a Kanab Ambersnail Workshop was held at the Phoenix Zoo, Phoenix, Arizona. Data on the status of the Kanab Ambersnail was presented to the attendees which included an expert review panel. The panel prepared a report entitled *Report of Kanab Ambersnail Review Panel on Taxonomic, Ecological and Translocation Issues Concerning the Conservation of Oxyloma snails in Arizona and Utah* (Noss et al. 1999). In the months following the workshop some individual comments and a compilation of comments from various representatives to the Kanab Ambersnail Work Group (KAWG) were prepared and copies are attached.

At your request members of the KAWG reviewed the expert panel's recommendations during their November 30, 2000, meeting to determine whether they, as a group, concurred with the panel's recommendations. The results of that discussion are attached. Three other documents previously produced which relate comments of KAWG members are also attached.

Attachments 4

Attachment

KAWG members present at the November 20, 2000 meeting

Mike Demlong, Clay Nelson, Jeff Sorensen - Arizona Game and Fish Department
Norm Henderson - Glen Canyon National Recreation Area
Eric North - Grand Canyon Wildlands
Della Snyder - Grand Canyon National Park
Larry England - Fish and Wildlife Service, Salt Lake City
Debra Bills - Fish and Wildlife Service, Phoenix
Gary Burton - Western Area Power Administration
Mark Miller - Arizona State University
Ralph Swanson - Central Utah Project Completion
Amy Heuslin - Bureau of Indian Affairs
Christine Karas - Bureau of Reclamation
Vicky Meretsky (via conference call) - Indiana University

Recommendation 1. Additional analysis of shell morphology, anatomy and molecular genetics (e.g. mitochondrial DNA), using state of the art methods, are urgently needed to resolve taxonomic, phylogenetic, and, in part, distributional questions.

Conclusion: Consensus

Recommendation 2. Additional field surveys of potential succieinid habitats both upstream of Glen Canyon Dam and downstream within the Colorado River drainage, as well as in regions outside th Colorado River basin.

Conclusion: Consensus, with the first two items most relevant

Recommendation 3. In contrast, additional translocation efforts and establishment of captive populations are not warranted.

Conclusion: No consensus. It is not clear if 'additional' includes Elves Chasm or just any population beyond this. What if this population ultimately fails? What if population at Three Lakes becomes extinct? What if Vasey's is a unique taxon? The Recovery Plan is still in effect and at least five members wanted to preserve the opportunity to continue implementing the plan as a means of reaching recovery and de-listing.

Recommendation 4. Population viability analysis of the Vasey's Paradise population, and probably other Oxyloma populations, is not likely to be informative or helpful for conservation of these populations; preferable alternatives to population viability analysis exists.

Conclusion: Consensus - but more information is needed.

Recommendation 5. Flooding from dam releases within the historic (pre-dam) seasons and levels is justified ecologically and is unlikely to pose a significant threat to the Vasey's Paradise snail population which appears to have evolved under an intense flooding regime.

Conclusion: No consensus. The group is not opposed to high releases in appropriate years. Factors such as recent climatic conditions and physical habitat would need to be considered (a

dry year preceding a flood year may have reduced the baseline; spring flow could change; rock slide/fall could have reduced habitat; etc.) The group noted that since the expert panel report was released, the Biological Opinion has been modified to accommodate flows up to 45,000 cfs; larger flows are not precluded but would require additional compliance.

Recommendation 6. No scientific basis exists for heroic efforts to maintain or create artificially large or multiple populations of the Vasey's Paradise snail [A]; instead, available information on historic ecology supports a minimally invasive approach to management of Vasey's Paradise and other populations of *Oxyloma* [B].

Conclusion: No consensus on part A; consensus on part B assuming some snails could be used to augment translocated populations. Key points of discussion among members of the KAWG were: moving snails out of the flood zone may be limiting downstream dispersal, additional populations, the group concurred. Recognizing the impacts of sampling, the number of trips has already been reduced and photogrammetry is being used - there was considerable discussion over what the panel meant by this recommendation: conduct no additional work, or, that the previous work was misguided? Group members did not agree that there was no basis for previous action, but the need for, type of additional actions is not clear. Some of the panel's rationale was based on the persistence of the species through time and its evolution in a highly variable system but the system is now drastically altered. Some KAWG members felt there was merit to translocation within and between populations. Members disagreed on creating artificially large or multiple populations (the need for redundant populations) and on the lack of scientific basis.

Recommendation 7. The Recovery Plan for the *Oxyloma* populations in this region should be re-written as soon as the major taxonomic issues are resolved [A]. The Vasey's Paradise population may warrant listing and conservation as a distinct, imperiled taxon, perhaps a single-site endemic [B].

Conclusion: Consensus on A; B will be determined once taxonomic issues are resolved, however an interim strategy for obtaining the recommended data and moving toward recovery should be developed.

Recommendation 8. The administrative and management implications of new taxonomic findings should be discussed and disseminated widely and promptly to all parties. Any subsequent management or recovery plans should be subject to a review process similar to that of this panel prior to implementation.

Conclusion: Consensus. Recovery Plans are published in the Federal Register for public comment.

Recommendation 9. Our conclusions suggest a reconsideration of current management direction for these snails and their ecosystems.

Conclusion: Consensus.

Responses to KAS Review Panel Recommendations by
Bureau of Reclamation Upper Colorado Region KAWG Members
Salt Lake City, Utah
June 27, 2000

EXECUTIVE SUMMARY

Members of the Kanab ambersnail Work Group in the Bureau of Reclamation Upper Colorado Region office have reviewed the report of Kanab ambersnail expert panel and the recommendations for future management actions. We greatly appreciate the panel's efforts, and are giving serious consideration to their recommendations. The Bureau of Reclamation, through the Glen Canyon Dam Adaptive Management Program, will pursue additional tests of beach/habitat-building flows of a greater magnitude, as well as other tests dam operations that could have effects on the *Oxyloma* population at Vaseys Paradise. Test flows which are different from those described in the Record of Decision will require additional evaluation under the National Environmental Policy Act and Endangered Species Act. The results of the expert panel's report will be used to formulate the impact analysis at that time. The panel completed their report as requested based upon the best information available, however, this was incomplete, as they stated in the report and leaves some remaining concerns.

A synopsis of our findings follows:

- We agree that our knowledge of the taxonomy, distribution, and ecology of the *Oxyloma* population occurring at Vaseys Paradise, and of other *Oxyloma* populations, is insufficient to make well-informed management decisions and that further studies of the taxon are warranted.
- We find a conflict in logic between the report's characterization of Vaseys Paradise as a representative highly variable environment subject to extreme fluctuations and containing snail populations that wink on and wink off, with the contrasting proposition that the only likely history of *Oxyloma* at that site being one of uninterrupted persistence since before the Pleistocene. We find other scenarios, including those acknowledged by the panel, as having sufficient potential not to be discarded, particularly in the face of our limited knowledge of the genetics, biogeography, and ecology of this taxon. It is possible that founder population previously existed which was inundated by the waters of Lake Powell, or still exists but has not been identified. Since other scenarios do not necessarily assume the continued long-term presence of the population to impacts imposed by natural hydrology and other environmental factors, we think a more conservative approach to the welfare of this population is warranted.
- We agree that the Fish and Wildlife Service incidental take limit should be re-evaluated in light of recent research results and the panel's findings.
- We agree that the frequency and intensity of monitoring the VP *Oxyloma* population should be evaluated with respect to impacts on the population and its habitat relative to benefits from information gained by that activity. We do not, however, think that the

existing level of monitoring has nearly the short-term or long-term effect on the population as would a 40% reduction in habitat.

- We agree that the parasite *Leucochloridium cyanocittae* does not represent a threat to *Oxyloma* populations or to other mollusk populations.
- We disagree with the contention that the risks of translocation and establishment of new populations outweigh the benefits afforded by redundant populations of a federally listed species to water and wildlife resource managers. We think that captive populations have a value for both research and educational purposes, even if they are unsuitable as sources for reintroduction.
- We agree with the necessity of revising the existing recovery plan for *Oxyloma haydeni kanabensis*. We think, however, that revision can not occur without additional new information on the identity and distribution of the VP *Oxyloma* and other *Oxyloma* populations. Therefore, we propose a recovery implementation plan be developed, complete with necessary tasks and a schedule of attainment, which, when completed, would provide the necessary information for plan revision.
- Based on language in the report, the panel seems to have been concerned that work being done to recovery the Kanab ambersnail has taken precedence over, or blocked implementation of other ecosystem management activities for the Grand Canyon as a whole. It is important to note that no proposed test flows have been prevented because of their potential to impact Kanab ambersnail, only that actions to minimize take or actions which the Service believed would prevent jeopardizing the continued existence of the species were implemented in conjunction with these tests. Likewise, Grand Canyon Monitoring and Research Center funding spent on these activities was used for compliance with the Endangered Species Act, which remains a legal responsibility of Reclamation. Voluntary, recovery activities, including the establishment of additional populations, experimental work at the Phoenix Zoo and University of Arizona, were funded from sources unavailable to Center.

FINDINGS

ISSUE 1: There is insufficient knowledge of the taxonomy and systematics of the genus *Oxyloma* in the Colorado River drainage to ascertain the identity of the Vaseys Paradise population and its relationship to other *Oxyloma* populations.

Panel Recommendation 1. Additional analyses of shell morphology, anatomy, and molecular genetics (e.g., mitochondrial DNA), using state-of-the-art methods, are urgently needed to resolve taxonomic, phylogenetic, and, in part, distributional questions.

Reply: We agree with the panel's recommendation. The taxonomic status of the *Oxyloma* population at Vaseys Paradise, and the relationship of that population to other *Oxyloma* populations, both within the Colorado River drainage and outside those boundaries, can not be ascertained adequately with our existing knowledge. The panel recommends a

genus-wide study, including Old World specimens. We agree that this broad spectrum is desirable, but we suggest that research should be prioritized on the basis of proximity to the Grand Canyon region populations, and that *Oxyloma* populations within the Colorado River drainage should be analyzed first. We also think it is imperative that results of research on *Oxyloma* populations presented at the workshop in December 1999, in both molecular genetics and anatomical arenas, should be published as soon as possible. KAWG members should seek funding, external to the Glen Canyon Dam Adaptive Management Program, to accomplish these tasks.

ISSUE 2: Presuming the *Oxyloma* population at Vaseys Paradise has been in existence for millennia, and that it has persisted during natural floods well in excess of those occurring since the emplacement of Glen Canyon Dam, is the Fish and Wildlife Service 10% incidental take limit justified.

Panel Recommendation 2. Floods that will result from proposed releases from Glen Canyon Dam (i.e., beach habitat-building floods of 45,000-90,000 cfs) will be well within the natural (pre-dam) range of variability. In fact, a strong case can be made that releases should be increased to more closely match the natural hydrologic regime, including inter-annual variability. There is no reason to believe that the population cannot survive floods of pre-dam magnitude (90,000-125,000 cfs or greater) in the future. There is no ecological basis for the 10% take limit set by the U.S. Fish and Wildlife Service, which corresponds to regulated floods (dam releases) of approximately 25,000 cfs (higher by some accounts). Additional field surveys of potential succineid habitats both upstream of GCD and downstream within the Colorado River drainage, as well as in regions outside the Colorado River Basin that provide potential habitat.

Reply: Many of the panel's recommendations rest on a set of assumptions, namely: (1) Vaseys Paradise is representative of other spring habitats in southwestern United States, which are "highly variable environments, subject to extreme flooding, drought, and associated fluctuations in water table and outflow." *Oxyloma* populations in the Southwest "were probably always isolated and were regularly decimated by natural events. Hence, populations of these snails can be assumed to have winked on and off over time." (2) The VP *Oxyloma* population has been continuously resident at that site for a very long time, at least since the beginning of the Pleistocene. It has not undergone extirpation and successive recolonization from one or more founder populations. (3) *Oxyloma* populations in Grand Canyon were always of very limited distribution. It is unlikely that the Vaseys Paradise *Oxyloma* population is a surviving population of a larger, and more widely distributed, complex

We find the assumptions upon which the panel based its findings questionable and, in some cases, contradictory. For example, if spring habitats in the desert southwest are as characterized, can we expect that the VP *Oxyloma* population has persisted continuously since at least the beginning of the Pleistocene? Or is it just as feasible that this population

has been periodically extirpated and then recolonized by dispersal from founder populations that remain undiscovered or have themselves been extirpated. Lack of other conspecific *Oxyloma* populations, whether extant or present only as fossil remnants, may be attributable to the limited surveys for mollusks in this region. Our point is that there are alternative histories and ancestories for the VP *Oxyloma* population and, potentially, for other *Oxyloma* populations in the Grand Canyon region. Unfortunately, the panel only alluded to them and did not describe them explicitly or give them adequate consideration in their deliberations. This is unfortunate, because most of the panel's recommendations for management rest on the assumption that the VP population has continuously occupied the site for many millennia in spite of the impacts of the Colorado River and other naturally occurring events.

We agree with the recommendation for additional surveys for *Oxyloma* populations, but we are not clear why this recommendation is being made if the panel recommends against further translocations. Again, we would prioritize the effort first to the Grand Canyon region. Additional funding outside conventional sources would undoubtedly have to be obtained to carry the investigations into other regions. As the Adaptive Management Program pursues test flows of greater magnitude, which will likely have greater impacts on the VP population, redundant populations become increasingly important given the uncertainties recognized in the panel's report.

ISSUE 3: This issue is focused on whether there is justification for differentiating primary and secondary habitats (defined by vegetation) for *Oxyloma* at VP, and whether there are characteristics of the VP site that create unique habitat for the *Oxyloma* population.

Panel Recommendation 3. No specific recommendations were made for this issue.

Reply: The panel found that ascribing all occupied habitat as "critical" to the *Oxyloma* population's survival was fallacious. They apparently misinterpreted the identity of secondary habitat, however, in that they held "the secondary habitat would not have been there consistently in any abundance under the pre-dam flow regime" and that it occurs only in the "lower zone habitat, below the 45,000 cfs line." Vegetation comprising secondary habitat is distributed widely across the VP talus slope, and is not restricted to the area that would have been affected by pre-dam flows.

ISSUE 4: Within Grand Canyon National Park, presumed Kanab ambersnails (*Oxyloma haydeni kanabensis*) are limited to VP, and no other populations have been detected in surveys of more than 100 seeps and springs. Is the VP *Oxyloma* *O. h. kanabensis*, what was the population's origin, how long has it been at VP, and what is its relationship to other *Oxyloma* populations?

Panel Recommendation 4. The panel noted that the VP *Oxyloma* population may be a "Pleistocene relict which was formerly more widespread" or "equally plausible that this particular

taxon has always been restricted to this site or a small collection of sites, whether narrowly or widely distributed, with other occurrences yet to be discovered." The panel concludes from "(w)hat is known, so far, of its genetics" that the VP *Oxyloma* population has been in place and isolated from other populations for a long time, "perhaps much earlier than the Pleistocene."

The panel advises against "frequent, intensive population surveys, because they are expensive and destructive of vegetation and snails." They suggest that an annual survey using a photographic series combined with observations of egg masses and young of year would be sufficient. Although they advocate against frequent, intensive population surveys, they are less concerned about loss of habitat from dam operations and find that "initial (habitat) take of 40% would almost certainly not threaten persistence of the snail population."

The panel believes that take of 40% of the currently occupied VP snail habitat would not threaten the population.

Reply: The panel has reached the conclusion that the most parsimonious explanation for the VP *Oxyloma* population's origin and ancestry is that it "has always been restricted to this site or a small collection of sites" and that it has been present at VP since "perhaps much earlier than the Pleistocene." They leave us with a dilemma because earlier they portrayed springs such as Vaseys Paradise as "regularly decimated by natural events" and their resident snail populations as having "winked on and off over time." If the VP population follows this pattern, it may have been periodically extirpated and subsequently re-established by individuals from other populations that may no longer exist, or that have not yet been discovered. Until further sampling, as advocated by the panel, is completed, or other populations are established through translocation, we find it difficult to accept the risk that take of 40% of the currently occupied habitat would not threaten the population.

We agree with the sentiment against more frequent and invasive sampling than is necessary to understand status and trends for the VP *Oxyloma* population. The KAWG should discuss the panel's recommendations and ascertain what level of sampling will be necessary to determine whether the population or habitat is declining and what factors are contributing to the decline. We also think, however, that periodic surveys of habitat and ambersnails in the upper habitat zone, which has only been assessed one time to date, must be accomplished to determine the baseline against which future management actions should be compared.

ISSUE 5: This issue concerns effects of managed flood regimes and overlaps with issues 2 and 4.

Panel Recommendation 5. The panel viewed floods as an element of a natural dynamic process, not something that destroys habitat. Only a "Noah-size" flood really threatens the snails.

Reply: The panel responds that "flooding is not "habitat destruction;" rather, it is a natural process that creates a variable patch dynamic characteristic of these riverine environments." Federal agencies faced with complying with the Endangered Species Act (ESA) can not assume this attitude toward managed floods when they adversely affect a listed species. The panel's response may be correct from an academic standpoint, but it belies their lack of understanding for legal requirements under the ESA. We continue to believe that redundant populations is the best means of insuring the continued existence of the species while evaluating the effects of test flows of greater magnitude.

ISSUE 6: This issue deals with avoidance of jeopardy by Requirement of ESA not to jeopardize species.

Panel Recommendation 6. The panel recommended against translocations, terming it an effort of last resort for use in emergency situations. They contended this practice leads to continued agency intervention, is expensive, and disruptive of the animals and habitats. However, the panel was supportive of re-introductions to areas of known previous inhabitation. The panel felt that species "resilience" was more important than any prescribed level of population or habitat stability.

Reply: We disagree with the conclusion that translocation efforts are not warranted. We see the sites of introduction as important insurance for the future when we assumedly will allow greater risks to the VP *Oxyloma* population by releasing higher beach-habitat building flows (BHBF) intended to benefit the entire ecosystem. We agree with the panel that attempts to establish snails at additional locations may not warranted at this time, but we think that augmentation of sites having already received ambersnails is justified, particularly if snails used for translocation are salvages from the effects of future BHBFs.

We disagree with the panel on the value of captive populations. Populations established at The Phoenix Zoo and at Glen Canyon Dam were never intended to be used for re-introduction or establishment of new populations, so that is not as issue. The dam population is a research population, held under a research permit, and not intended for long-term purposes. The zoo population has a definite role to play in educating the public about southwestern springs, their flora and fauna, and species listed under the Endangered Species Act. We consider these purposes worthwhile and the populations justified.

ISSUE 7: Infection by the parasite *Leucochloridium cyanocittae* and the importance of preventing its dispersal during translocations

Panel Recommendation 7. The panel found this to be a "non-issue," except to restate their position that further translocations are not justified.

Reply: We agree with the panel's conclusion on the lack of danger to *Oxyloma* or other snails from transfer of the parasite. It should be noted that because there was insufficient information available regarding the parasite, only small snails believed to be free of the parasite were translocated.

➤ **ISSUE 8:** Criteria for establishment of new populations and justification of the action.

Panel Recommendation 8. Establishment of new populations is not justified. The recovery plan and biological opinions for the VP *Oxyloma* population should be re-written as soon as the major taxonomic issues are resolved. The Vaseys Paradise population may warrant listing and conservation as a distinct, imperiled taxon, perhaps as a single-site endemic.

Reply: We agree with the necessity of updating the recovery plan and are willing to assist the Fish & Wildlife Service in achieving that objective. We also think that there is a large amount of knowledge to be gained on the identity and distribution of what is now deemed to be the Kanab ambersnail at VP before the recovery plan can be revised. Therefore, we propose that a recovery implementation plan be written as a bridge to the revised recovery plan. The plan would lay out a list of actions and a schedule for completion. When completed, results of the proposed actions would provide the necessary information to revise the recovery plan. The revised plan would undergo the same degree of public review, including a notice of availability in the Federal Register and public comment period, as any other recovery plan prepared by the Service.

What happens next?

The Bureau of Reclamation does not intend to re-consult on the preferred alternative which is contained in the Record of Decision. However, Reclamation and the Service are formulating an amendment to the January 7, 1995 and February 16, 1996 biological opinions to correct an inaccuracy regarding the level of take occurring from a BHBF of 45,000cfs. Any future test flow different from the ROD will require ESA consultation and NEPA review. Assuming a finding of may affect in Reclamation's biological assessment, formal consultation will be required. The Service will develop a biological opinion with a reasonable and prudent alternative (RPA) if they determine the proposed flow will jeopardize the continued existence of the species. The Service will include reasonable and prudent measures (RPM) designed to minimize take, and terms and conditions for their implementation, if incidental take will occur. We have no reason to believe that we will be unable to identify an RPA or RPM for future consultation, as has been done for all past consultations to date.

The position statement presented below comprises the individual viewpoints of Jeff Sorensen, Clay Nelson, and Michael Demlong concerning Kanab ambersnail research and management, specifically addressing recommendations by the KAS expert review panel.

This statement does not comprise an official AGFD position.

1) ADDITIONAL TAXONOMIC AND GENETIC STUDIES

We agree that additional taxonomic, genetic, and character analyses of ambersnail populations are urgently needed, and interagency cooperators should make it a priority to secure funding for this work. Future studies should contain more robust sample sizes from each population, incorporate additional markers in genetic analysis, and improve collaboration and synthesis of data between taxonomists and geneticists in reporting to resource managers. While peer-reviewed manuscripts are the preferred medium for disseminating results, agency reports will suffice in order for resource managers to make timely decisions affecting ecosystem management. Likewise, if new management decisions on the Vaseys Paradise (VP) population are to be made soon, then perhaps it is best to focus additional studies on ambersnail populations of the Colorado River Basin first, rather than the global distribution of succineids as proposed by the review panel. A thorough investigation of the whole family of Succineidae may be overly ambitious given the likelihood of available funding, personnel, and logistical resources. An exhaustive genetic/ morphologic study and revision of the Succineidae family may take several years to complete, whereas administrative concerns require decisions much sooner. We encourage Stevens, Wu, and Miller to publish their recent findings and continue additional genetic/morphologic studies. Although Wu has retired, the KAWG should inquire on his availability to continue identifications of ambersnails or pursue his recommendations of other landsnail taxonomists.

2) ADDITIONAL HABITAT SURVEYS

We agree that additional field surveys of potential succineid habitats is warranted, particularly throughout watersheds within the Grand Canyon region. Although potential habitat may exist outside this region, surveys should initially be focused in this area using cooperative efforts among private, state, and federal resources. If additional funding and personnel become available, these surveys could be expanded beyond the Colorado River Basin. A formal study of mollusk fossil distribution throughout this region may add insight into the historical range of the genus *Oxyloma* and other native landsnails.

3) TRANSLOCATION AND CAPTIVE POPULATIONS

We believe the associated Biological Opinions on KAS and dam operations and the 1995 KAS recovery plan may need to be reviewed, to reflect new information and alternative management options. Until these legal obligations and conservation guidelines are changed, we will continue to support the monitoring of all wild populations of KAS (including translocated populations in

the Grand Canyon), and further research with captive experimental and refugium populations. It is advisable not to pursue introductions of KAS to any new sites, other than the three previously approved sites in Grand Canyon, until additional taxonomic/genetic studies and more widespread habitat surveys are completed. Initial attempts to establish a new population of KAS at "KeyHole Spring", Upper Elves Chasm, and Lower Deer Creek are valid activities to meet recovery objectives for the species and to alleviate Biological Opinion restrictions on the operation of Glen Canyon Dam. KAS translocations to new sites met the required environmental compliance review process, and provided an active approach in endangered species conservation not without precedent. As of October 1999, KAS appear to be establishing at Upper Elves Chasm with new progeny and successively greater population densities observed with each visit. These new populations have full protection under the Endangered Species Act, and are not "non-essential, experimental" like many other reintroduced native wildlife. In light of the genetic uniqueness of the VP population, we recommend the Upper Elves Chasm population receive limited augmentation to maintain genetic variability and boost population demographics. If Upper Elves Chasm becomes a successful establishment site (i.e. self-sustaining), then several legal restrictions to future BHBFs will be reduced.

We disagree with the review panel concerning the usefulness of captive KAS populations. These populations provide data on life history, ecology, husbandry, and observation error tests, that would be difficult or impossible to gain in a field setting. Captive experimental and refugium KAS populations also provide education and outreach opportunities. The KAS interpretative display at Glen Canyon Dam (overlooking the outdoor enclosures) is viewed by thousands of visitors each year. A proposed artificial desert spring exhibit at The Phoenix Zoo (with a KAS interpretative panel) would also inform the general public about native riparian species and the role of springs in the Grand Canyon ecosystem. We recommend maintaining the Northern Arizona University (NAU) experimental population and The Phoenix Zoo refugium for research, conservation, and educational goals. The Glen Canyon Dam population should be relocated to either Denver's Ocean Journey Park or back to NAU. The information gained in the construction of captive enclosures, maintenance of habitat, and sampling techniques may prove to be very useful for preserving and propagating other critically endangered mollusks or spring invertebrates.

4) POPULATION VIABILITY ANALYSES

We support the investigation of non-invasive, scientific approaches that will increase our ability to conserve KAS. several mathematically-based methods (i.e. elasticity analysis and habitat dynamics models) exist which can better estimate KAS population dynamics at VP, and should be considered in future management decisions. Population and habitat models for KAS should be founded on empirical data from wild and captive populations. Initial population viability analyses of the VP KAS were designed to determine what life history data was missing, and to evaluate the range of stochastic variation using current bootstrapped estimates. We believe future research should attempt to answer these life history questions, and use new or modified sampling methods to improve population estimates (specifically in the reduction of wide variances associated with extrapolation).

5) HISTORIC AND CURRENT FLOW REGIMES

We concur that flooding from dam releases, within historic levels, ecologically benefits the river ecosystem. Provided, the VP KAS population is equally abundant in the upper slope habitat of the spring. Only one survey was made in this upper habitat in 1995, at a time when sampling methodology for KAS and habitat area was still being refined. Current bootstrapping estimates of the VP population contain huge variances and varying degrees of extrapolation error. The comparison of KAS abundance in the upper habitat versus the lower habitat of VP needs to be statistically supported with adequate sample data. If few KAS actually occupy the upper slope of VP, the ability to sustain a viable population after a large, historic-level flood may be greatly diminished.

6) VASEYS PARADISE AND THE 10% TAKE LIMIT

It may be inaccurate to describe the current VP habitat and ambersnail population as “unnatural” or “artificially large”. During the last 50 years, Glen Canyon Dam has created major environmental changes in the downstream ecosystem. However, the successful colonization of available flood-zone habitat by VP flora and fauna is a natural process in direct response to environmental changes (whether human-caused or natural variation). Historically, the VP habitat may have expanded and contracted due to any number of environmental factors (i.e., wet or dry periods, changes in spring pourouts). Habitat size and KAS abundance at VP may be within the range of natural variation, but this is difficult to quantify without historic data. Turner and Karpiscak (1980) show some variation in extent of VP habitat due to flood scouring in re-matched photographs from 1923 and 1974. Dam operations can attempt to mimic natural disturbance processes through the use of BHBFs, but not all of the natural process or resources of the historic river ecosystem exist today.

We support past and current efforts by the USFWS and USBR to reduce incidental take of VP habitat and KAS conservation activities. To remove the legal limitations to future BHBFs, the USBR could re-consult with the USFWS on the Biological Opinions concerning KAS and dam operations, and continue current conservation activities in the interim. We will continue to support recovery plan objectives or science-based revisions, and believe that the decisions made with regards to the Biological Opinions were justifiable and appropriate based on the best available data. In 1994, the 10% incidental take limit of VP habitat was accepted by all involved agencies as a conservative measure and in the best interest of the species. This decision was made at a time when no ecological data or population estimates for VP was available. Management should allow flexibility over time, and it may be appropriate to modify levels of take based on new information and the status of the VP KAS under various climatic cycles and population trends. It should be noted that the recovery plan and Biological Opinions were created with the perception that they would be revised as additional information, improved population distributions, and new management strategies became available. We support a continuation of research, to gain a better understanding of KAS life history, ecology, propagation, observation error of various sampling techniques, and monitoring of wild and captive KAS populations to determine trends in population dynamics.

7) RECOVERY PLAN REVISION

We would support efforts to revise the 1995 KAS recovery plan to reflect new information and management options. If the revision is to wait for the results from additional genetic and morphological studies, then it may be a couple years before this priority task is accomplished (see above comment on additional taxonomic and genetic studies). It is suggested that an interim draft or similar interagency management strategy be written and implemented with adaptive management options for KAS, and acknowledging that the VP snails are genetically distinct. A great deal of new information can be incorporated now into the revised plan, while additional research is in progress.

8) ADMINISTRATIVE AND MANAGEMENT DECISIONS

We agree that all administrative and management implications of new findings pertaining to KAS should be disseminated to all interested parties in a timely manner. The KAWG has been exemplary in promoting communications through quarterly meetings since 1995, providing administrative support, and participation in the December 1999 KAS workshop. Compared to other species of concern in the Grand Canyon ecosystem, the KAWG provides an active and functional forum for interagency discussion and coordination of KAS conservation efforts. Future management plans should continue to be reviewed by the KAWG and subjected to a review process as appropriate to allow for additional perspectives prior to implementation.

A timeline perspective of conditions and events involving KAS in the Grand Canyon region:

- 1909 - KAS first discovered in Kanab Canyon, Utah; later a second, larger population is discovered at Three Lakes, Utah (both sites on private land).
- 1948 - Pilsbry revises the taxonomic identity of KAS to its current sub-species status.
- 1976 - Cole and Kubly visit VP--snails found are believed to be *Lymnaea* (probably KAS?).
- July 1991 - KAS discovered at VP by Spamer and Stevens; surveys of the Kanab Canyon locality fail to find any KAS--that population is believed to be extirpated due to de-watering.
- August 1992 - KAS emergency listed as endangered by USFWS; planned commercial development threatens the Three Lakes population.
- May 1993 - Bills and Stevens make a reconnaissance visit of VP.
- 1994 - Stevens begins searching for additional KAS populations along the Grand Canyon river corridor.

September 1994 - Interagency research on the VP population begins (Section 6 funded).

December 1994 - USFWS issues a biological opinion on the operation of Glen Canyon Dam and the planned 1996 BHBF--terms and conditions establish the 10% level of incidental take of VP habitat and the need for ecological studies of the VP KAS.

October 1995 - KAS recovery plan approved by USFWS.

February 1996 - A biological opinion is written on the March BHBF of Glen Canyon Dam.

March 1996 - A 45,000cfs BHBF impacts the VP site (~16% total habitat lost); interagency biologists move 1275 affected KAS above the flood zone at VP, and continue monitoring of VP KAS and habitat through October 1997.

April 1996 - A biological opinion amendment is written on the flood effects of the March BHBF.

June 1996 - AGFD begins habitat surveys in the Grand Canyon and northern Arizona to find additional KAS populations or suitable habitat--continue surveys through 1998. Initial genetic analysis of regional *Oxyloma* populations conducted.

1997 - VP habitat still not recovered from 1996 BHBF; to alleviate biological opinion restrictions to future BHBFs, AGFD enters a co-operative agreement with CUPCA to establish a new population of KAS in Arizona; The Phoenix Zoo agrees to establish a zoological refugium for KAS and begins building enclosures; USBR provides a grant and logistic support to AGFD to continue habitat surveys and further recovery and biological opinion activities to establish new populations of KAS in Arizona.

August 1997 - 248 KAS translocated from VP to conduct experimental captive-breeding studies at Northern Arizona University--continues through December 1999.

February 1998 - AGFD and NPS-GRCA begin the environmental compliance work for establishing a new population of KAS in the Grand Canyon; AMWG and TWG increase the planning for a BHBF in 1998; VP monitoring contracted out to SWCA for 1998-99.

July 1998 - An EA and BE on KAS translocation submitted for public review; Meretsky re-discovers the Kanab Canyon population (actually several metapopulations) located on private land and BLM land.

August 1998 - Both the EA and BE are finalized--three sites in Grand Canyon National Park are selected for KAS translocation; The Phoenix Zoo KAS refugium enclosures are completed, but available habitat is limited (delay start up till 1999).

September 1998 - NPS-GRCA submits a FONSI on KAS translocation, and USFWS responds with a biological opinion authorizing the action; 450 young KAS are collected from VP

and translocated to the three sites (150 KAS per site); 450 KAS from the NAU experiment moved to outdoor enclosures at Glen Canyon Dam to further captive-breeding studies--continues through December 1999.

October 1998 - Monitoring of translocation sites begins--few KAS found at each site; a preliminary criteria for establishment determination is proposed by USFWS and NPS-GRCA; new genetic/morphological study of U.S. and Canadian ambersnails planned.

January 1999 - AGFD and GCMRC begin the planning and coordination of an independent expert review panel and interagency workshop for KAS; AMWG and TWG continue planning for a second BHBF, possibly in 1999.

May 1999 - 50 KAS from VP translocated to The Phoenix Zoo to start the captive refugium.

July 1999 - Augmentation of translocation sites with an additional 450 KAS from VP after new progeny and survivorship detected at all three sites; additional ambersnail populations discovered in Utah; new genetic/morphological study of ambersnails in U.S. and Canada underway--results due in November; review panel for the KAS workshop selected.

October 1999 - One of three translocation sites (Upper Elves Chasm) appears to be succeeding in establishment of KAS (lots of new progeny and mature KAS entering dormancy).

December 1999 - KAS workshop held at The Phoenix Zoo; new findings and the current status of regional KAS populations are discussed among the review panel and interagency participants--genetic/morphological studies generally inconclusive, except VP KAS are genetically distinct from other populations studied; panel recommends no further translocation of KAS, more genetic/morphologic work, more habitat surveys, and reduced VP monitoring.

January 2000 - TWG & AMWG briefed on the KAS review panel recommendations. KAWG begins commenting on these recommendations and developing questions of clarification.

February 2000 - KAWG meets to discuss recommendation and concerns. KAS review panel refuses to respond to additional questions unless additional money and new information is provided.

COMMENTS ON THE KAS REVIEW PANEL RECOMMENDATIONS

FROM THE INTERAGENCY KANAB AMBERSNAIL WORKING GROUP

Compiled by Jeff A. Sorensen
Arizona Game and Fish Department

February 28, 2000

This document contains a compilation of comments from the various field investigators, resource managers, and agency/organization representatives of the Kanab Ambersnail Working Group. These comments are in reference to the recommendations provided by the expert review panel of the Kanab Ambersnail Workshop (December 1999 at The Phoenix Zoo, Phoenix, Arizona). The Kanab Ambersnail (KAS) Review Panel recommendations are contained in the document entitled "Report of Kanab Ambersnail Review Panel on taxonomic, ecological, and translocation issues concerning the conservation of *Oxyloma* snails in Arizona and Utah" (Noss et al. 1999).

Rick Johnson. Environmental Consultant
Affiliated with Grand Canyon Trust

I attended the panel workshop in December, and I've read over the report. In general, I think that the panel was very thoughtful and logical, and that they have performed an important service for us. My response to specific items ranges from mild disagreement (or perhaps it was some uncertainty about what they were suggesting), to strong agreement.

Regardless of my personal feelings, this panel was a top-notch, and I feel compelled to take their suggestions seriously. I appreciated the forthright nature of the comments, but I also think a few of them hit, I assume unintentionally, below the belt. It's clear to me that everyone has the best interests of the species in mind.

It seems to me that we need to focus our time and energy on our interests rather than past positions. One immediate need is to revise the recovery plan for Kanab ambersnail and decide whether the Vasey's taxon should be listed if it is indeed a separate species.

The other immediate need is to provide input into the AMP's strategic plan which is currently being developed. For the strategic plan, I recommend that we assume that the ambersnail at Vasey's is a distinct taxon, and use the panel's report to make recommendations to the AMWG for a set of Management Objectives, Information Needs, and Management Actions necessary to meet the goal for the Vasey's taxon. The goal (which may be approved at the upcoming AMWG meeting) is to "maintain or attain viable populations of Kanab [the Vasey's Paradise taxon] ambersnail." I've been a

part of the strategic plan ad hoc committee, and I would be happy to work with the KAWG in crafting the components of the ambersnail goal. (1/11/00)

David Wegner, Environmental Consultant
Ecosystems Management International, Inc.

(A letter to Jeff Sorensen):

Thank you for providing the final Report of Kanab Ambersnail Review Panel on Taxonomic, Ecological, and Translocation Issues Concerning the Conservation of Oxytoma Snails in Arizona and Utah. The panel did a good job of assimilating a great deal of information in a short period of time and providing cogent recommendations. Their approach to me reflects a broader conservation approach for species in general with direct applications to the species in the Grand Canyon. Their conclusions do address the historic approach the biological opinion and field studies should have been more rigorously reviewed, however, at the time the decisions and original biological opinion was being implemented, it was done with the species foremost in everyone's mind. We did not have all the information desired or the time to collect it all. The FWS, in consultation with others, did the very best job possible given the constraints at the time.

The Grand Canyon is a special place and our approach has always been conservation of the species and habitat first. Once lost, they are not likely to be brought back. Several statements made, identify that the historical system was very dynamic which resulted in large fluctuations in the populations of the species. This is true. Unfortunately, the rest of the story was not related. Today we have a system that is largely controlled by the releases from Glen Canyon Dam and as such the ability of the habitat and species to rebound is likely reduced substantially.

I concur with the panel that:

- Additional research should be done on morphology and genetics of the species. Information presented at the workshop leads one to conclude that, based on the scientific effort to date, the species may be more diverse and complex than we thought.
- Additional surveys of potential succineid habitats should be done upstream and downstream of Glen Canyon Dam. I suspect that the species did inhabit the side canyons of Glen Canyon before the dam, and probably served as supply and refugia capable for reestablishment of impacted populations after high floods.
- The minimal invasive approach should be implemented now that we understand and can scientifically support future management actions. I think we have been stating that all along.
- Based on the new information it is appropriate that the Recovery Plan be revised and updated. If the Vasey's population is distinct then it should be protected under a separate listing. The FWS has to take the lead on this issue with guidance from the

KAS Working Group after adequate scientific review of the information (see below).

- The information presented by Miller and Wu should be written up and provided to the entire group for further review. The technical information should be subject to a scientific review to ensure quantitative credibility. A great deal of new information was presented at the December workshop that warrants critical review before we make potentially long lasting decisions from it.

I do not agree with the conclusions related to potential managed high flow release levels and translocation. The system that supported the snail at Vasey's Paradise prior to the dam does not exist now. The dam clearly impacts the distribution of snails and vegetation. Until the Fish & Wildlife Service is requested by Reclamation to rewrite the Biological Opinion or provides other guidance, I believe we should stay the course for the protection of the species and to maintain as many options as possible for future management actions.

I do agree with you (Jeff) and Dr. Meretsky that we should consider two trips a year, one to determine the overwintering survival and the other to determine end of season population's numbers. I would suggest that the Vasey's Paradise site continue to be a location for quantitative science and evaluation. We should continue to collect the photographic evidence annually as a qualitative data point and not potentially compromise the species or habitats until we have completed the scientific recommendations that the panel made.

Today the Grand Canyon is a fragmented ecosystem separated from upstream source areas for snails and plants by the concrete dam. I do concur that large seasonal and annual fluctuations of snail numbers likely happened before the dam. Now the system has changed and we need to recognize that in long-term management actions. We should look at the ecosystem perspective and take into account the relationship of the species to the overall changes going on within the river corridor.

The Fish & Wildlife Service must take the next step in regards to future studies and actions with this species. A new Recovery Plan with specific recommendations for ecosystem and species level actions should be requested by Reclamation and accomplished as soon as possible. Until that time I think it would be inappropriate to reduce the quality of the studies or our protection of the species and habitat.

Lastly, I would like to address the role of monitoring in Grand Canyon. Since 1983 the Western Area Power Administration and the Bureau of Reclamation have been financially and administratively supporting the collection and analysis of ecosystem and species level information in Grand Canyon. Today the data set for the Grand Canyon represents one of the better-documented and supported assemblages in the Colorado River basin. In 1988 we were faced with a similar situation of cutting back the science. The Bureau of Reclamation reduced the level of monitoring in the Grand Canyon due to the impending decisions regarding the potential of an Environmental Impact Statement at Glen Canyon Dam. Due to funding cycles and inevitable agency discussion, the years

1989 and 1990 resulting in only minimal research and monitoring. The result was a significant loss of important biological and physical data. Data that could never be reproduced or replaced.

The National Research Council rightfully criticized the Glen Canyon Environmental Studies for the reduction in monitoring during this critical period. The interim studies that were accomplished did not have the scientific rigor necessary to be used for quantitative analysis. We could never recover that data or information and as a result were left with critical data gaps. It is essential that monitoring not be dropped until a scientifically supportable alternative approach is developed, funded, and implemented. We ended up spending considerably more money on the EIS due to the loss of the information in 1988 and 1989. Data cannot be produced after the fact or developed from a model.

I appreciate the fine effort that you and AGFD made for the workshop. The process and the people worked well and you should take credit for your efforts. (1/12/00)

Debra T. Bills, Wildlife Biologist
U.S. Fish and Wildlife Service, Arizona Ecological Services Office

The FWS will not be able to provide you with an agency position on the KAWG review panel recommendations by Jan. 18th. Some things to consider from my perspective. The first line of the Conclusions state:

We conclude that the recovery plan and biological opinions regarding the Vasey's Paradise and other *Oxyloma* populations should be revised as soon as the major taxonomic and distributional issues are resolved by further morphological, anatomical, and molecular genetic studies and new field surveys.

It is not clear to me how we proceed in the interim. Completing these tasks could take years. Seeking funding sources should be a priority.

Also, note that the Recovery Plan revision process can be lengthy. FWS guidance is that Recovery Plans should be revised as needed, about every 5 years. I have not heard any discussions about revising the 1995 document for which Region 6 (Larry England) is lead. Revising the biological opinion(s?) could be done at anytime that we receive a request for re-consultation from Reclamation. (1/12/00)

Gary Burton, Environmental Protection Specialist
Western Area Power Administration

Other than a slightly harsh treatment of FWS in Issue 8, I don't think we could have asked for a more professional, consistent, and to the point response from the panel. I

really have no other comment related to their assessment of the information presented other than to commend them for a job well done.

As to their recommendations, I agree with Debra in that I am not positive what tack we take from here. I certainly think we should act on (adopt, revise, decline) their recommendations in the short-term, rather than initiating a year-long (or longer) discussion about what to do. Sounds like a first order of business for the KAWG! I also would encourage FWS, Recovery Team members, and Reclamation (with help from the rest of us) to begin looking at timely and expeditious ways to address the upcoming regulatory issues. (1/14/00)

Lawrence E. Stevens, Environmental Consultant
Affiliated with Grand Canyon Wildlands Council

I thoroughly second Gary's comments, in all respects, including the timing of the next KAWG meeting earlier, rather than later in February. I think you did your agency a credit in bringing the panel together, and they did a great job, even though it may be hard to accept/follow their recommendations. (1/14/00)

Barbara Ralston, Biologist
Grand Canyon Monitoring and Research Center

I support the panel comments and Gary Burton's suggestions. (1/18/00)

R.V. Ward, Wildlife Biologist
National Park Service, Grand Canyon N.P.

I have reviewed the panel recommendations and I am in overall agreement with them. I believe our highest priorities should be preservation of the Vasey's Paradise population (whatever it turns out to be) and securing funding for the necessary taxonomic work as outlined by the panel. I believe that the Vasey's population is relatively secure as suggested by the panel and that we should seek revision of the Biological Opinion and Recovery Plan in light of their recommendations.

I recommend that we continue monitoring the translocated populations, but undertake no further translocation efforts until the taxonomic research and historic distribution questions posed by the panel are answered. (1/18/00)

Ralph Swanson, Environmental Compliance Specialist
Central Utah Project Completion Act Office

The subject report is enlightening and represents an objective, if sobering, review of our actions to date in the KAS recovery process. You and Arizona Game and Fish Dept. are to be commended for convening the group and soliciting their input. They clearly disagree with our approaches, but they make compelling arguments that we should consider very seriously. I think they have made very rational recommendations for a future course of action.

My main reactions to their conclusions are:

1. The most important conclusion of the panel, in my opinion, is that the VP snail, whatever its species name, is-- and long has been-- secure at VP under all historic flow regimes. BHBf, within historical ranges (as much as 300,000cfs is postulated by the panel), should not adversely affect the VP species, although habitat and individual snails will be lost. I am convinced by the panel that we are being needlessly concerned about the security of this snail at this site vis-a-vis the currently proposed BHBf program. As a group we should focus our attentions on the second most important conclusions of the panel as discussed in #2.

2. I support the panel recommendations to: 1) pursue resolutions to, or at least more clarity surrounding, the taxonomic and systematic mysteries that currently baffle us, and 2) field surveys and searches for additional populations of the VP snail and/or KAS at locations above Lake Powell and below the Grand Canyon. Our group should lead on this, but we need the academic community to advise us on these technical matters. Someone such as Dr. Wu should help us map out a logical course of action to resolve the taxonomic questions, and Vicky Meretsky and you should advise on a logical and systematic plan for field work that targets likely areas and is reasonable as to time and costs. If we can resolve these questions, BR might be able to comply with any Biological Opinion conditions FWS may care to impose on the BHBf program without need for translocation of VP snails.

3. We should continue to monitor the fate of the three translocated populations of VP snail, but we should not consider either additional new translocations or augmentation of the three existing efforts. For now, we have complied with the Biological Opinion mandate to continue BHBfs, but our future efforts should be on resolving taxonomic and range questions before implementing additional active management actions.

I note the panel was against introductions of the VP snail outside its historic range ("artificial expansion"), but supported re-introductions of a species within its historic range as a legitimate (albeit desperate) management and recovery technique. The panel therefore was not opposed to our translocation work. They simply argued we should understand the "historic range" of a species and take care to stay within it. We thought we were doing that, but they argue convincingly that we do not understand the range and that should be our first task. I concur.

4. I agree the dam population of the VP snail should be moved to ASU or be sacrificed for the taxonomic work we need to do. The costs and risks of maintaining that

population cohort are not justified by the benefits. BR, AGFD and FWS should work together to terminate that experiment.

5. Far too much is being made of the 10% incidental take "limit" and the issue should be dropped. I believe the review panel has misunderstood the concept of "incidental take" and the derivation and application of the 10% figure. The panel is incorrect in stating that the 10% figure has "no ecological basis." True, it may have a very weak ecological basis, but absent any better data, FWS is justified, under the Section 7 regulations, in extrapolating from an estimated 10% loss of habitat to an equivalent 10% anticipated loss of snails. The job of FWS is to estimate the take they anticipate will occur "incidental to" implementation of the proposed action. That is what they did. They are not justified in saying "only 10% loss will likely occur from this BHBf, but you can take up to 40% because we don't think that will harm the species." If BR and FWS wish to revisit the incidental take issue in re-consultation that is between them and should not be an agenda item for our group any longer.

The Biological Opinion conclusion that BHBfs no higher than 25,000 cfs should not be contemplated prior to discovery or establishment of another secure KAS population also may have a weak foundation. However, if FWS erred in this, even ecologically, they did so on the side of species conservation, which is justified, in my opinion. We can argue that FWS should have given greater weight to the magnitude of known historic flows (up to 300k cfs) that have affected the VP population and habitat, but it is their call under the law and I would expect them to be conservative with regard to species conservation. Again, BR can reargue that issue with FWS.

This report certainly justifies re-initiation of formal consultation between BR and FWS in my view, but that is solely up to BR and FWS. Our concerns lie with implementing recovery actions that are in the best interests of the snail.

6. The VP snail is the KAS until FWS says differently. The panel arguments serve only to strengthen the already-considerable doubt that exists in our minds, and further argues that action is needed to resolve this question so that logical management actions can proceed. However, until the issue is resolved, we must observe the species designation.

7. Our group should recommend to the FWS that the Recovery Plan be revised per the guidelines of this report. However, the decision to revise resides with FWS. If they do not wish to do so, parties to the current Recovery Plan could notify FWS that they will no longer participate in the plan, because it appears to be incorrect and biologically unsound. (1/18/00)

Christine Karas, Environmental Protection Specialist
U.S. Bureau of Reclamation, Upper Colorado Region

Like everyone, I thought the workshop was well done and useful for sharing information. I have a few concerns though, and would like to share them.

The panel cited the Glen Canyon Dam management concerns as "a classic case of conflict between ecosystem-based management and management for the benefit of individual, imperiled species". This statement in the report raises a concern over whether the panel was attempting to make a value judgement or give a scientific evaluation. I found it a bit confusing because I believe that using an ecosystem approach means you need to first identify the most fragile components of the ecosystem, and having done so, give them higher priority over more resilient components. I believe the ESA helps us to do this by focusing on species (and their habitats) which have been determined to be at risk of extinction, as identified by the FWS, through a peer reviewed public process (listing). However, this listing determination requires periodic review as new information becomes available, thus the expert panel was assembled.

They recommended the appropriate conservation target or unit of management be the entire suite of succineid snail populations, which I agree would certainly be the ultimately goal, and result in the most sound conclusions. Unfortunately, federal agencies are somewhat limited in this regard considering they lack the jurisdiction over species which are not listed or located on federal lands, and the authority to expend AMP funds on this larger geographic is not clear. Similarly, the opinion of the panel is useful regarding the approach the ESA takes to conservation, (conserving ecosystems vs. species by species) however, we remain bound to abide by the law and regulations as currently written. These recommendations point out the need for increased state, tribal and private involvement in resolution of the issues.

The panel was given the extremely difficult task of rendering their opinion based on a small amount of incomplete data, and that fact is repeated over and over in the report: "molecular genetic analysis is unclear...it is not clear that any true KAS have been analyzed yet...the scale and significance of distinctions is unclear...a rigorous phylogenetic framework to demonstrate this [*Oxyloma*] distinctness is not yet in place...[KAS is] a species which was formerly more widespread...it is equally plausible that the particular taxon has always been restricted to this site....no definitive answer exists to question of what proportion of the population can be lost in a given year without adverse long-term consequences...". These statements of uncertainty (and many others) necessarily run through the entire report because definitive information on many parameters is not available.

The most solid recommendation is to continue to refine the data through better morphological and genetic studies and though searching for *Oxyloma* snails more expansively. Unfortunately, this raises the management questions of: What if anything should we be doing in the meantime, and how would limited resources be best spent-- further research/habitat searches, or conducting activities which may or may not be necessary or beneficial? I can argue for and against each! In other words, do we want to risk waiting several years and spending considerable dollars developing better information in the hope we will be relieved of the need to protect the Vasey's Paradise site, or risk pursuing potentially unnecessary measures which will allow higher dam

releases in the absence of definitive data? To me, the only answer can be: Which ever will be the fastest!

I concur that the take level should be revisited, and although the report states they do not find 10% to be scientifically justifiable, they do not recommend a certain % of allowable take to replace it, and state they are not sure what level it should be, so we cannot expect a scientifically grounded revision. Similarly, the recovery plan should be revisited at some time in the future, but it is unlikely this will result in much change without new definitive data. (1/18/00)

Eric North, Landsnail Researcher
(unaffiliated)

I finally got a chance to look at the report (thanks for the second copy) and find myself in complete agreement with every major point made by the panel. I would have to agree with Larry and Gary in their recommendations in how to proceed. I'd also like to congratulate you again and thank you for the opportunity to participate in and contribute to the workshop. The result of having an expert panel of such varied backgrounds come to a complete consensus on nearly every issue presented is a result of the great job you did in organizing, planning and presenting the workshop.

One thing I did disagree with on the Panel's recommendations was with the refugium at TPZ. I guess I don't remember if they suggested to drop the project or to continue to use it as study for life history and ecology information, but it also serves as an educational tool for visitors, which in turn, raises public awareness. This would be a great place to expand, and include information on how important it is to conserve these types of habitats (any wetlands-ecosystem approach!!) and better understand them, especially in the face of the predicted prolonged dry period facing the Southwest. You know, this IS the same type of approach that should be taken with limestone talus slopes, such as the one harboring the "San Xavier Talussnail." (1/21/00)

Vicky J. Meretsky, Assistant Professor
Indiana University

I am in agreement with the vast majority of the report, although I see an educational benefit to the dam population, and little chance of contamination of wild stocks from it. The quality of the report exceeded my expectations, which is not at all a criticism of anyone - merely a reflection of amount of information that needed to be conveyed, the time frame available in which to convey it, and the nuances involved in the whole thing. Congratulations to you - it must have been several tons of work. (2/4/00)

Mark P. Miller, Graduate Student, Landsnail Genetics
Northern Arizona University

I thought the panel did an excellent job of digesting all of the material that was presented at the meeting. Congratulations on a job well done. Above all else, their recommendations make sense. I think their suggestions for future research should be followed, and in my opinion, there are numerous additional aspects of KAS basic biology that still need to be better understood. But I think we're off to a good start.
(2/14/00)

Michael J. Demlong, Clay B. Nelson, & Jeff A. Sorensen. Wildlife Biologists
Arizona Game and Fish Department

(A draft agency position on KAS issues has been prepared, but is still under internal review at this time.) (2/28/00)

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**Report of Kanab Ambersnail Review Panel on Taxonomic,
Ecological, and Translocation Issues Concerning the
Conservation of *Oxyloma* Snails in Arizona and Utah**

Reed Noss (chair), Mark Gordon, Elaine Hoagland,
Charles Lydeard, Patricia Mehlhop, and Barry Roth

Introduction

Our panel was assembled to review the research and conservation efforts made in behalf of the Kanab ambersnail (*Oxyloma haydeni kanabensis*) and related taxa of succineid snails in the Colorado River drainage of Arizona and Utah, with emphasis on the population at Vasey's Paradise in Grand Canyon National Park. A long-standing issue is how water releases from Glen Canyon dam might be modified to match more closely the natural flow regime and provide ecosystem-level benefits, such as building beach habitat along the Colorado River downstream from the dam, and how these flows may affect endangered species such as the Kanab ambersnail (KAS). This issue has been cited as a classic case of conflict between ecosystem-based management and management for the benefit of individual, imperiled species. The issue is made more poignant by the fact that the Vasey's Paradise population is within a national park, where the prevailing management paradigm is natural regulation. Complicating the issue further, the taxonomic identity of succineid snails at Vasey's Paradise and elsewhere in the region has been called into question with recent molecular genetic studies suggesting that the Vasey's Paradise population is distinct from all others and probably is not KAS.

This report addresses eight issues, each of which carries a set of specific questions that were presented to our panel for consideration. Our responses to the questions carry the assumption that the population at Vasey's Paradise, although probably not KAS, is an unique taxon that deserves protection. Moreover, given the taxonomic uncertainties and indications that multiple *Oxyloma* taxa may be present and potentially imperiled in the Colorado River drainage, we suggest that an appropriate conservation target, or unit of management, is the entire suite of succineid snail populations and their highly variable habitats. This "ecosystem" approach is more consistent with the first stated goal of the Endangered Species Act of 1973, which is to conserve the ecosystems upon which threatened and endangered species depend, than is the current management approach, which emphasizes intensive species-by-species and site-by-site efforts.

Among the general conclusions of our review, reported in more detail in our responses to specific questions, are the following recommendations:

- Additional analyses of shell morphology, anatomy, and molecular genetics (e.g., mitochondrial DNA), using state-of-the-art methods, are urgently needed to resolve taxonomic, phylogenetic, and, in part, distributional questions.
- Also urgently needed are additional field surveys of potential succineid habitats both

upstream of Glen Canyon dam and downstream within the Colorado River drainage, as well as in regions outside the Colorado River basin that provide potential habitat.

- In contrast, additional efforts at translocation and establishment of captive populations are not warranted.
- Population viability analysis of the Vasey's Paradise population, and probably other *Oxyloma* populations, is not likely to be informative or helpful for conservation of these populations; preferable alternatives to population viability analysis exist.
- Flooding from dam releases within the historic (pre-dam) seasons and levels is justified ecologically and is unlikely to pose a significant threat to the Vasey's Paradise snail population, which appears to have evolved under an intense flooding regime.
- No scientific basis exists for heroic efforts to maintain or create artificially large or multiple populations of the Vasey's Paradise snail; instead, available information on historical ecology supports a minimally invasive approach to management of Vasey's Paradise and other populations of *Oxyloma*.
- The Recovery Plan for the *Oxyloma* populations in this region should be re-written as soon as the major taxonomic issues are resolved. The Vasey's Paradise population may warrant listing and conservation as a distinct, imperiled taxon, perhaps a single-site endemic.
- The administrative and management implications of new taxonomic findings should be discussed and disseminated widely and promptly to all parties. Any subsequent management or recovery plan should be subjected to a review process similar to that of this panel prior to implementation.
- Our conclusions suggest a reconsideration of current management direction for these snails and their ecosystems.

It is noteworthy that our team reached consensus on every major issue, with no dissenting opinions. This is a remarkable achievement, and rare for such panels, especially considering that our team represented diverse areas of expertise, including molluscan anatomy, morphology, taxonomy, and systematics; molecular genetics; evolutionary ecology; landscape ecology; conservation biology; and environmental policy.

Issue 1

This issue involves the molecular genetics, shell morphology, internal anatomy, and taxonomy of *Oxyloma* snails in the Colorado River drainage. We find that neither of the current statements, morphological/anatomical or DNA-based, on ambersnail taxonomy is adequate to describe the

taxonomic status of the populations in question. Although the morphological/anatomical and molecular genetic assessments appear to conflict, both studies are so preliminary that the apparent conflict may not mean much. The available information indicates an urgent need for revision of the specific and subspecific taxonomy of *Oxyloma* after further study.

The morphological/anatomical study by Shi-Kuei Wu was not presented with enough rigor for us to evaluate its conclusions. Clear, replicable character state definitions and a data matrix of characteristics versus taxa are needed to resolve problematic systematic relationships. More specimens and populations also need to be examined. The DNA-based study by Mark Miller resolved well at the level of the traditional genus (i.e., *Succinea*, *Catinella*, *Oxyloma*), although one of the two "*Succinea*" clades may represent *Novisuccinea*, which the best modern taxonomy recognizes as a full genus. Nevertheless, the DNA-based analysis provided only minimal resolution within the *Oxyloma* clade. We were not given complete information on the genus-wide study, and several minor errors (e.g., incorrect localities) were apparent in these results.

We also note that the DNA results were based on only a portion of a single gene, cytochrome B, and no non-succineid out-groups were employed in the statistical analyses. Additionally, the partial use of the cytochrome B gene, and the related relatively low number of base pairs, in the analyses suggests potential degradation of some tissue samples. The entire cytochrome B and other genes, for example more rapidly evolving ones, should be studied and might provide better resolution of taxa. Any subsequent molecular genetic investigations should be conducted, at least in part, by a professional with expertise in molluscan systematics. We recommend a genus-wide study of *Oxyloma*, including Old World specimens. In fact, a thorough systematic treatment of Succineidae is in order.

(1A) *Is it appropriate to identify ambersnails exclusively, or primarily, based on morphological characteristics?* It is not yet clear that ambersnails can be identified reliably at the species level or below based on reproductive anatomy or shell morphology, alone or in combination. Resolution might be possible with more rigorous qualitative and quantitative criteria in place.

(1B) *What is the current understanding of KAS distribution in northern Arizona and southern Utah based on genetic analyses?* The current understanding of KAS distribution in the region based on molecular genetic analysis is unclear. The DNA-based study was unable to resolve taxa within the *Oxyloma* clade, with the possible exception of the Vasey's Paradise population. We make two observations in this regard: 1) The only samples that might be topotypic KAS (*Oxyloma haydeni kanabensis*) are 40.304 and 40.305, which cluster as zero-length branches in the middle of the *Oxyloma* clade. These specimens, however, were not identified as *kanabensis* by Wu on the basis of shell morphology or reproductive anatomy. Thus, it is not clear that any true KAS have been analyzed yet or that its differentiation from *O. haydeni sensu stricto* is warranted. Further morphological or anatomical study may alter this conclusion. 2) Other purported KAS from areas that have been studied ecologically (e.g., Vasey's Paradise, Three Lakes, -9 Mile, Indian Garden) are "all over the map" genetically according to Miller's analysis. Miller's preliminary study, which addressed only the above four congregations, demonstrated that

they are distinct from one another. The scale or significance of these distinctions is not clear, however. Furthermore, the four congregations nest differently in the large study than in the preliminary study.

(1C) *Is the Vasey's Paradise (VP) population unique?* The Vasey's Paradise population is genetically unique (distinct), i.e., it has three gene changes that the rest of *Oxyloma* do not have and lacks seven that the rest have, based on Miller's Figure 2 (tree #1 of 32 equally parsimonious phylogenies). We conclude that it is likely that the Vasey's Paradise population is a distinct, presumably undescribed species, but a rigorous phylogenetic framework to demonstrate this distinctness is not yet in place.

(1D) *How do recent discoveries, experimental results, and observed findings alter the current understanding of ambersnail taxonomy for populations in the Grand Canyon region?* Recent discoveries, results, and findings highlight the need for improved morphological, anatomical, and genetic study on which to base taxonomic, policy, and management decisions. The decision-making process can be no better than the underlying taxonomy.

(1E) *In seeking to establish additional populations of KAS at new sites in Grand Canyon, would it contribute to genetic exchange and population viability to translocate snails from more than just the VP site?* No. As discussed later in this report, we recommend against translocation.

(1F) *Is inbreeding a significant risk factor for the translocated VP KAS?* From what is known, no.

Issue 2

This issue concerns the observed wide seasonal and annual fluctuations of the Vasey's Paradise population in relation to the 1994 biological opinion of the U.S. Fish and Wildlife Service that "incidental take will assume to be exceeded if more than 10% of the occupied habitat in Grand Canyon will be inundated by high flows or a controlled flood." To put this issue into perspective, we note that *Oxyloma* snails in the Southwest inhabit highly variable environments, subject to extreme flooding, drought, and associated fluctuations in water table and outflow from springs and seeps. Suitable habitats for these snails, although probably more widespread during full glacial periods of the Pleistocene as well as wet periods of the Holocene, were probably always isolated and were regularly decimated by natural events. Hence, populations of these snails can be assumed to have winked on and off over time. This is the ecological milieu in which these populations evolved and continue to evolve. Populations that persist a long time in isolation have a high probability of becoming genetically distinct, which may be what has happened in the case of the Vasey's Paradise population (see Issue 1), although we cannot be sure that differentiation took place at the Vasey's Paradise site.

Our team was presented information (primarily from Larry Stevens) showing that habitat for the Vasey's Paradise snail population increased by at least 40% after construction of Glen Canyon

Dam and cessation of natural flooding. The population undoubtedly increased earlier, but by an indefinite amount, in response to the invasion of the site by the non-native watercress (*Nasturtium officinale*), now a preferred food. The post-dam increase in habitat and population for the snails is an artificial phenomenon. There is no ecological basis for the 10% take limit set by the U.S. Fish and Wildlife Service, which corresponds to regulated floods (dam releases) of approximately 25,000 cfs (higher by some accounts). The 1996 experimental beach habitat-building flow of 45,000 cfs took about 15% of currently occupied habitat, whereas an unplanned flood of ca. 100,000 cfs in 1983 took approximately 33%. The snail population at Vasey's Paradise recovered to its unnaturally high level within three years of the 1996 flood (recovery after the 1983 flood was not monitored). In contrast, average *annual* flooding before the dam was at a level of 90,000-125,000 cfs, which would correspond to a take of 30-40% of currently occupied habitat.

The floods that will result from proposed releases from the dam (i.e., beach habitat-building floods of 45,000-90,000 cfs) will be well within the natural (pre-dam) range of variability. In fact, a strong case can be made that releases should be increased to more closely match the natural hydrologic regime, including inter-annual variability. That the habitat at Vasey's Paradise has recovered and persisted despite such floods is indicated by the similarity of the present scene to John Wesley Powell's description of the site more than a century ago (in Stegner, 1992, *Beyond the Hundredth Meridian*, Penguin Books edition). The Vasey's Paradise snail population presumably persisted for a long period of time with annual floods of around 125,000 cfs, and with occasional floods (i.e., 100-year events) of twice this level or more. There is no reason to believe that the population cannot survive floods of these magnitudes in the future.

(2A) *What is the natural mechanism of dispersal for KAS or similar snail species to expand their range?* Passive dispersal through rafting (e.g., in clumps of dislodged vegetation) and carriage on birds are the primary means by which *Oxyloma* snails colonize new habitats and re-colonize habitats from which they have been extirpated. Populations in meadows versus seep habitats probably relied on different mechanisms. For example, carriage on birds is probably more common for meadow populations, whereas rafting can be assumed to be more important for populations inhabiting riverside seeps. Within Vasey's Paradise, dispersal downslope to colonize new habitat exposed with lower, post-dam water levels has been documented. Hence, snails are able to colonize nearby habitat actively, presumably by crawling, whereas long-distance dispersal is passive.

(2B) *Is this dispersal enhanced or depressed by dam operations?* Dispersal of land snails has always been haphazard. Successful colonization is a rare event. There is no evidence that the dam has depressed the dispersal of snails. Surveys below the dam have failed to turn up any additional populations. Again, we emphasize the need for new field surveys in the Colorado drainage above the dam, including potential shoreline habitats along Lake Powell and in the tributaries currently draining into it, further surveys downstream from known populations (including tributaries of the Colorado, e.g., the Virgin River below Zion National Park, where potentially suitable wetland habitats are available according to Vicky Meretsky), and in regions adjacent to the Colorado

River basin that support similar habitats.

(2C) *How was the VP population able to recover and reinhabit VP after extreme high flow events before the dam was built?* Ambersnails follow post-flood revegetation, recolonizing substrates exposed after floods. The species at VP appears to have evolved in this kind of habitat and flow regime for a geologically long period. They are adapted to this variability through high fecundity and other mechanisms. Dispersal is not necessarily limited; rather, suitable habitats for colonization are limited, so successful colonization is a rare event. The question of precisely how the snails recovered and reinhabited habitats after pre-dam floods is not particularly relevant. The important fact is that they did and can be assumed to do so again, albeit infrequently.

Issue 3

This issue is focused on the Vasey's Paradise (VP) site and raises questions about the vegetative habitat of the snail population there.

(3A) *Is it appropriate to distinguish primary and secondary habitats, and extent of use, or is it enough to know that the snails use it, therefore it's of critical value?* What is defined as secondary habitat is the lower zone habitat, below the 45,000 cfs line. To assume that all vegetation currently occupied by the snails is of critical value to the persistence of the snail population is fallacious. We believe it is generally appropriate to distinguish secondary from primary habitat at VP; the secondary habitat would not have been there consistently in any abundance under the pre-dam flow regime. Therefore, it is presumably not critical to the persistence of the snail.

(3B) *What are the critical biotic and abiotic characteristics of the VP site that create unique habitat for KAS only at this location in the Canyon?* The VP population exists at VP probably as a consequence of a chance historical event. The question assumes that the site is unique. It may not be. The equilibrium theory of ecology would support the assumption that all favorable habitat will be occupied, whereas unfavorable habitat will be unoccupied. The alternative non-equilibrium view, which has more scientific support, suggests a large role of chance colonization and extinction events in shaping distributional patterns. At a given point in time, many areas of favorable habitat may be unoccupied, whereas marginal habitat may be occupied (at least temporarily). Over time, populations at individual sites often wink on and off. Nevertheless, we note that the VP site appears at this time to be quite different from other habitats in the region that contain populations of *Oxyloma* snails. The significance of this difference is unclear, given the lack of thorough knowledge of *Oxyloma* taxonomy and distribution.

Issue 4

This issue, which states that, within Grand Canyon National Park, KAS is restricted to VP and that no other populations have been detected at more than 100 other springs and seeps in the Canyon, is based on the assumption that the VP population is *O. h. kanabensis*. The conclusion

that the VP population is KAS has been thrown in doubt by recent molecular studies (Miller). Although no populations have been detected downstream, intensive surveys have not been conducted in many suitable habitats. This issue also suggests that the VP snail is a Pleistocene relict which was formerly more widespread. Although this may be true, it is equally plausible that this particular taxon has always been restricted to this site or a small collection of sites, whether narrowly or widely distributed, with other occurrences yet to be discovered. What is known, so far, of its genetics (see Issue 1) suggests that it is a long-branch taxon that diverged from a more basal portion of the phylogenetic tree; hence, its separation from other *Oxyloma* populations, whether by dispersal or vicariance, probably took place a long time ago, perhaps much earlier than the Pleistocene. The questions below, and our responses, are partially redundant with Issue 2, addressed earlier.

(4A) What percentage of snails can be lost in one year, or consecutive years, without adverse long-term consequences to the population (given the high inter-annual variability in population size)? No definitive answer exists to the question of what proportion of the population can be lost in a given year without adverse long-term consequences. Nevertheless, this question should be interpreted in light of the historic flow regime. Under natural conditions, the VP snail population would have fluctuated from year to year depending on the severity of flooding, drought, temperature, and other factors. It seems to be a “r-selected” species, with a short life-span, high reproductive potential, and a population regulated largely by density-independent, physical factors. In order to monitor the status of the population, we suggest a minimally invasive approach using photographic series combined with annual observations of egg masses and young of the year (i.e., if egg masses and young can be found with relative ease, then the population can be assumed to be of viable density) until a reasonably predictive model of population responses to flooding can be developed. The model can then be validated periodically with new surveys. We caution against frequent, intensive population surveys, because they are expensive and destructive of vegetation and snails.

(4B) Given the recent information on KAS population status and ecology, should the 10% take limit of VP habitat still apply to current management of Glen Canyon Dam operations? No. The 10% take limit has no basis in science. Suitable habitat for the snail population at VP has increased by more than 40% since building of the dam and, before that, by colonization of the site by *Nasturtium*. Variable flood events up to 125,000 cfs annually—with occasional, much higher flows (e.g., 200,000 - 300,000)—are part of the natural disturbance regime and can be assumed to pose no long-term threat to the snail. An initial flood event of 125,000 cfs would “take” approximately 40% of currently occupied VP snail habitat. Thereafter, annual flows of approximately this magnitude would take a very small percent (if any) of the habitat, because the snails would be restricted to a smaller area more similar to their pre-dam distribution at the site.

(4C) What percentage of habitat protection is appropriate to ensure long-term survival of the VP KAS population? As explained above, initial take of 40% would almost certainly not threaten the persistence of the snail population. The question of the percentage of habitat protection needed appears misguided. A more important consideration is the perpetuation of the natural processes

that create and renew a variety of natural habitats within the broader ecosystem.

Issue 5

This issue, which again concerns managed flood regimes and their impact on the VP snail population, is largely a restatement of Issue 4 and also overlaps with Issue 2. We addressed this issue for VP in Issue 4; available data do not allow us to address the issue for the other *Oxyloma* populations. This difficulty underscores the need for further field studies and taxonomic work before establishing a long-term conservation strategy for these populations.

5A) *Can we establish or predict what level of habitat destruction would most likely have long-term adverse consequences to a local KAS population or to the species throughout its range?* As suggested by our response to questions #4A-C, no. Moreover, it is important to recognize that flooding is not “habitat destruction,” rather, it is a natural process that creates a variable patch dynamic characteristic of these riverine environments.

(5B) *What information is necessary to establish a population viability index for KAS, with a reasonable degree of confidence?* We seriously doubt that population viability analysis (PVA) or development of a population viability index (whatever that is) will produce information of much use for the conservation or management of *Oxyloma* snails and their habitats. We suggest that PVA is generally not appropriate for annual species, nor is it suitable for a species whose population size and demographic parameters are so difficult to estimate, as suggested by past sampling problems and data sets limited by the sampling methodology employed.

Several alternatives to PVA may be more appropriate for *Oxyloma* populations. Elasticity analysis can be used to estimate the proportional change in population growth rate for a proportional change in vital rates (i.e., survival, growth, reproduction), using a projection matrix based on life-history stages (for an overview, see Benton and Grant, 1999. *Trends in Ecology and Evolution* 14:467-471). Elasticity analysis has been applied successfully to many species with a wide variety of life histories. Such analysis can help managers determine the life-history stage that, when varied, has the greatest impact on overall population size or persistence. In conjunction with elasticity analysis, a detailed habitat dynamics model could be used to predict the impacts of floods and other disturbances of different levels on vegetation and population dynamics. This general kind of approach has been called “species-centered environmental analysis,” which begins by organizing prior knowledge about the factors that limit the population of interest, then considers results from new studies to evaluate alternative explanations for how environmental factors and various management actions might affect populations (see James et al. 1997, *Ecological Applications* 7:118-129). These approaches generally do not provide the “hard numbers” of PVA (persistence times, probabilities of extinction, etc.), but it has become increasingly apparent that such numbers are usually wrong and almost always misleading. In any case, we suspect that viability of the VP snail population is linked most strongly to the probability of a major catastrophe (i.e., a Noah-sized flood), which could be an entirely natural event.

(5C) *Is the time it takes for habitat to recover critical to the viability of the KAS population?* This question is irrelevant if we assume (as we recommend) that a natural, annual flooding regime will be mimicked by dam releases.

(5D) *If the VP habitat (KAS host plants) are somehow protected from flood scour, can KAS in the affected habitat withstand 2-4 days of inundation and displacement from river currents?*

Experimental evidence is that the snails cannot withstand this level of inundation and displacement, as snails died after 17 hours of immersion. We do not recommend protecting KAS host plants from flood scour, nor do we recommend moving snails within the lower-zone habitat out of the way of flood waters. This expendable portion of the population, however, could serve as the source of individuals for taxonomic, physiological, and other studies.

Issue 6

This issue involves the requirement of the Endangered Species Act that actions funded, authorized by or carried out by a federal agency should not jeopardize a listed species. Management actions taken so far at Vasey's Paradise to avoid jeopardy have included moving snails to higher ground before floods and translocating snails to new locations within Grand Canyon National Park and to captive refugia in zoos and elsewhere. As explained in our responses to the questions below, our panel believes that such actions are misguided and unnecessary to conserve this taxon.

(6A) *Is moving an endangered species an appropriate, ongoing method to protect the species?*

As we stated in our response to question #5D, we do not think moving snails to higher ground is worthwhile. Nor do we think translocation, in this instance, is a wise practice. In some cases translocation of an endangered species has been shown to further the conservation and recovery of the species. This intensive effort, however, should be seen as a last resort. Although there is precedent for translocations of endangered species in the region, the record of success is generally poor. Historical distributions, present distribution, and taxonomy should be thoroughly resolved before considering translocation in any case. Our panel believes that translocations into sites where no previous records exist is not advisable except under emergency circumstances. Translocation commits agencies to perpetual active intervention (e.g., population augmentation, monitoring, and associated surveys) which is expensive, destructive of the habitat and individuals of the natural population, and not justified by the available scientific information and reasoning.

(6B) *Are there other options?* Management of the *Oxyloma* populations at their present locations in a minimally invasive way is our preferred alternative. Reintroduction to sites where a species is verified to have occurred in the past, and where suitable conditions for persistence remain or can be restored, is an important adjunct to protection and management of currently occupied habitat. This style of reintroduction is consistent with the strategy of restoring natural processes, such as floods.

(6C) *Does the historic distribution of an imperiled species (wide-ranging or narrow endemic)*

suggest different conservation strategies? Yes, it can. Hundreds, perhaps thousands, of species in North America have their known, current ranges restricted to single sites. An unknown proportion of these narrow endemic species, but undoubtedly many, have always been restricted to single sites or small constellations of sites. Restoring any species, whether formerly wide-ranging or endemic, to areas it previously occupied is a legitimate conservation action whenever the circumstances for such restoration are favorable. In contrast, artificial expansion of the range of a narrow endemic is not justifiable biologically or in terms of conservation strategy.

(6D) *Should an endemic mollusk be considered secure if its habitat appears stable and its population is considered both viable and defensible?* The idea of stability is problematic for habitats that are naturally dynamic, which all habitats are to one degree or another. Resilience—the ability to recover from periodic disturbance—is a more appropriate concept. Examples exist of populations going extinct due to disease and other factors, while their habitat remained intact. Distinguishing between background rates of extinction versus human-caused extinctions is often difficult, although it is well accepted that humans have recently increased overall extinction rates well over background levels. Over long periods of time, the natural fate of most small populations (e.g., narrow endemics), with or without human influence, is extinction. Indeed, the natural fate of any species is extinction. Meanwhile, other isolated populations slowly differentiate into new species, some of which expand their ranges. Outside of the mass extinction events recorded in the fossil record, and that occurring now as a consequence of human activity, the rate of speciation slightly outpaced the rate of extinction. *Oxyloma* populations should be considered reasonably secure if they are fluctuating, along with their habitats, within a historic range of variation. Then, they have a good chance of persisting and evolving for a long time.

(6E) *Does the risk of translocation outweigh the reward of reduced likelihood of extinction?* Intensive intervention always carries risks. If a historic flow regime is restored, there will be fewer expendable individuals available for translocation. Moving individuals to higher ground within the VP site is not a defensible strategy. We do not recommend further translocations or further augmentation of the populations already established within Grand Canyon National Park. On the other hand, we do not recommend extermination of translocated populations within the Park at this time. We do not see a useful conservation-oriented purpose for the captive populations (refugia). These populations exist in an artificial selective regime and may harbor diseases that potentially could be disastrous if introduced to the wild. We recommend that the captive populations not be the source of individuals to return to the wild. On the other hand, they may be useful for controlled laboratory research. The dam population, because it could result in unintentional releases of snails to the wild and artificial gene flow, should be exterminated or transferred to the populations at Northern Arizona University or the Phoenix Zoo.

Issue 7

The Vasey's Paradise snail population and the population at Three Lakes are known to be infected by a parasitic trematode, *Leucochloridium cyanocittae*. This symbiotic association of

Oxyloma and *Leucochloridium* is probably ancient and close, although the worm has been found in other succineid taxa (e.g., *Catinella*). No evidence suggests that the parasite has a significant, negative effect on the snail population. Infected snails, which make up a small proportion of the population, have been observed to reproduce normally, although possibly with depressed fecundity. The conservation of the worm is ultimately as worthwhile as the conservation of the snail. The issue of how the worm should be treated in snail translocations is not particularly relevant because we do not believe that translocations are warranted.

(7A) *What measures should be undertaken when introducing KAS to new locations to reduce parasite infection?* This question assumes that further translocations will take place, which we recommend against. Nevertheless, if translocation were to take place, we do not believe that measures to reduce parasite infection are warranted. This is a non-issue.

(7B) *Should the parasite also be intentionally (or incidentally) moved, or should efforts be taken to use only parasite-free specimens?* Again, we do not recommend translocation, but if it were to take place, moving the natural parasites and other symbionts of the snails would be proper.

(7C) *Are there risks of adverse effects on other snail species already inhabiting sites for KAS introduction?* No. If the parasite could potentially infect these other populations, it probably would have done so already.

Issue 8

This issue cites the U.S. Fish and Wildlife Service's biological opinion for the 1996 beach habitat-building flow, which required formal consultation if incidental take from flows will exceed the 10% limit established in a 1995 biological opinion. Our panel concludes that the biological opinions were not reasonable, neither at the time they were established nor especially today, given the increased information available. The 10% take limit and similar opinions are not justified by available knowledge of the biology of these species. It appears that the U.S. Fish and Wildlife Service has been preoccupied with setting and enforcing arbitrary and biologically naïve statutory requirements, rather than promoting broader conservation goals. We note that a broader strategy (i.e., one that takes into consideration evolutionary and ecological processes, as well as a greater variety of taxa and habitats) may better achieve the goals of the Endangered Species Act and other conservation legislation in the long term. Hence, it is important not just to follow the letter of the law, but also the spirit of the law to sustain, within natural bounds, these continually evolving lineages within the context of their dynamic ecosystems.

As discussed earlier, we do not believe that the establishment of new populations through translocation is a sound policy. Although the Vasey's Paradise population and taxon may have been more widespread in the past—and may be more widespread now than we know—no evidence exists to support such speculation. Given available information, it is just as reasonable to assume that the taxon evolved at its present site, or nearby, and has always been approximately as rare as it is now. The 10% take limit does not correspond to the distribution of habitats and

operation of natural processes under a pre-dam flow regime. Furthermore, the criteria for success by the establishment of new wild populations are not reasonable, nor is the idea of establishing new populations outside the known, natural range of each taxon reasonable.

Recent surveys have found new *Oxyloma* populations in Utah. Until the taxonomy of these populations is resolved, we have no idea how many populations of each taxon are extant. In any case, the requirement to establish 10 populations of KAS before downlisting can occur has no basis in science. It seems unreasonable to require any populations to be translocated until taxonomic and survey work has been completed. The three populations of KAS that exist under current taxonomic assumptions provide sufficient replication of populations, especially considering the size of the Greens population. The Alberta population, tentatively identified as *kanabensis* by Wu, is questionable due to the immaturity of the specimens.

(8A) *In attempting to establish new populations, what period of time (persistence) or number of successful generations is reasonable to consider the population a success?* We do not recommend establishment of new populations. Nevertheless, if the currently translocated populations are to be monitored, 10-30 years (generations) may be required to judge the translocation a success. As before, we recommend against intensive, frequent population surveys, as they are destructive of habitat and snails.

(8B) *How close geographically can ambersnail populations be to each other and still be considered distinct?* The geographic distance separating populations is relevant only to the extent that relative distance determines the probability of a single, catastrophic disturbance affecting both populations. Populations can be considered distinct if they are unlikely to be extirpated by the same catastrophic event, such as a flood or landslide. Virtually the only conceivable major catastrophe, in the near term, that would extirpate populations in the Grand Canyon is dam failure, which would probably eliminate populations and suitable habitat up to 500' above current water level.

(8C) *Could genetic variances in newly discovered KAS congregations be considered significant enough to change our assessment of the number of known KAS "populations"?* We cannot answer this question until further molecular genetic studies have been conducted and the taxonomy of these populations is resolved. The targets for conservation should be whatever taxa are distinguished by this work.

(8D) *What should be the boundaries for establishment efforts--historic ranges versus state/political boundaries?* We favor basing boundaries for reestablishment on documented historic ranges only.

(8E) *Should establishment efforts concentrate within the known geographic range or extend outside this range?* We suggest that all efforts be conducted within the known range. Protection of extant populations (within historic, pre-dam ranges of variation) is the highest priority.

Conclusion

We conclude that the recovery plan and biological opinions regarding the Vasey's Paradise and other *Oxyloma* populations should be revised as soon as the major taxonomic and distributional issues are resolved by further morphological, anatomical, and molecular genetic studies and new field surveys. Current, intensive actions (protection from flow-induced take, intensive population surveys, translocations, management of captive populations) taken on behalf of the Vasey's Paradise population cannot be justified by available scientific information or reasoning. We note that funds for the conservation of this and other endangered species are limited and are likely to remain so; hence, they must be spent on actions that will best meet conservation goals in the long term, including the primary goal of the Endangered Species Act to conserve the ecosystems upon which threatened and endangered species depend. With regard to the Vasey's Paradise population, assuming no increased anthropogenic threats, historical (pre-dam) patterns of vegetation inundation and loss and associated fluctuations in the snail population do not pose a significant threat to population persistence.

Acknowledgments

The panel unanimously agrees that this was one of the best organized, most efficient, and most productive panels on which we have participated. The organizers of the workshop, especially Jeff Sorensen of the Arizona Game & Fish Department, deserve the highest praise for making this event so worthwhile. They presented us with essentially all the information that is currently available and relevant to the issues discussed here. That our panel's recommendations are somewhat at odds with current policy and management direction on the part of state and federal agencies is no reflection on the competence of the staff, which we found to be of the highest caliber. To other participants in the workshop, especially the researchers, we express our gratitude and thanks for sharing their data and opinions in such a selfless and congenial manner.